EE326 Final Project Proposal: Lane Detection

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1 Introduction

As self-driving car become an emerging booming technology, several main technical issues began to be widely researched including obstacle detection, routine planning, road lane detection and danger estimation. Within all the issues, an important one is road lane detection, in other words, to extract the line on the road, so the computer can decide the exact direction which the car will go. In this project, we will analysis the existing technology and improve the robust of the system without the application of neural network.

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2 Conclusion of Existing Research

2.1 Algorithm

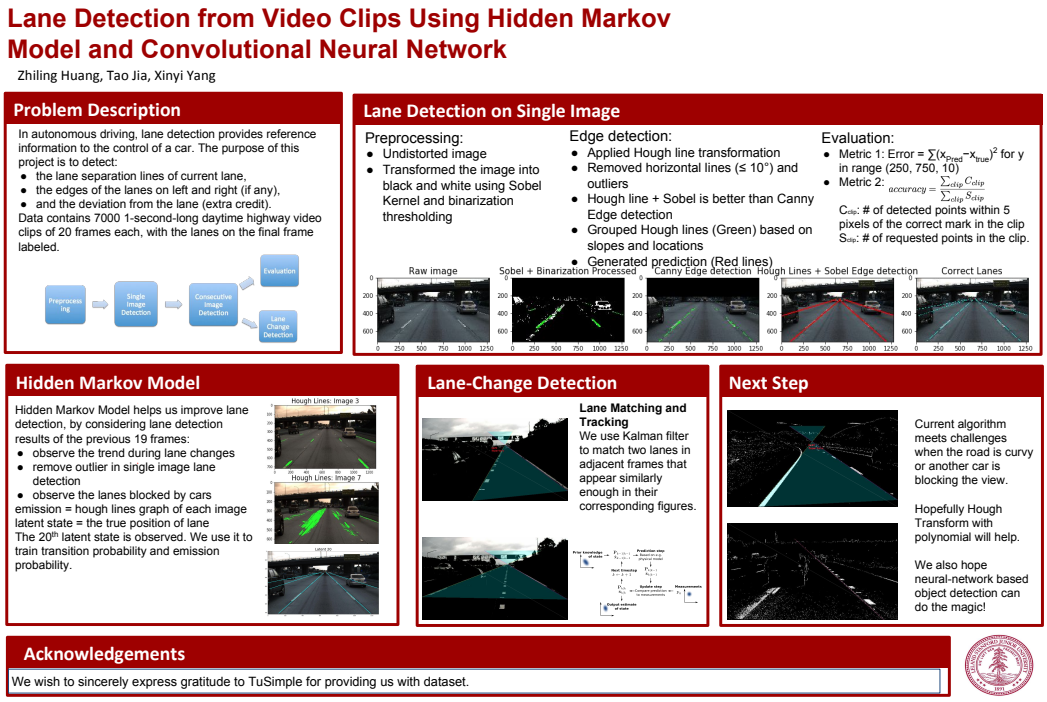


Figure 1. A poster proposed by Zhiling Huang, Tao Jia, Xinyi Yang

The current algorithm includes edge detection, binarization, ROI (region of interest) detection and feature extraction, which will be specifically discussed in the section 3. However, in real world test, engineers found that only by vision the road can not be detected precisely, so many other assistance technology was added to self driving car like laser radar, high precision map system and even sometimes the self driving system will use the behavior of other cars, to detect the road. However, such assistance technology cost a lot and are not suitable for some special user environment. On self-driving drive automobile with low cost, camera is always the most economic device for road detection. So in this project we will focus on improving the ability for visionary road lane detection.

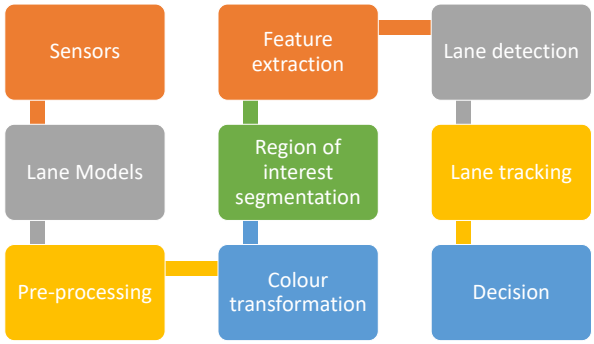
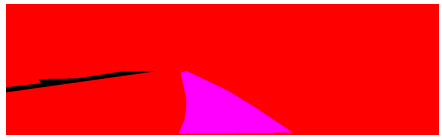


Figure 2. Road with poor maintenance conditions.

2.2 Existed Datasets

Two famous datasets intend for traffic lane recognition has been proposed. Jannik Fritsch and Tobias Kuehnl from Honda Research Institute Europe GmbH created the dataset called ”The KITTI Vision Benchmark Suite”[1], which consists of 289 training and 290 test images of the traffic lane image in urban and suburban area.

(a) Training dataset of KITTI Vision Benchmark Suite



(b) Testing dataset of KITTI Vision Benchmark Suite

Figure 3. KITTI Vision Benchmark Suite

Another dataset was proposed later in 2017, which was intend for ”TuSimple Competitions for CVPR2017”[2], this datasets mainly contains the traffic lane and sign in the highway and express ways.

Figure 4. Example Image of TuSimple Competitions for CVPR2017

3 Desired Workflow of Lane Detection

The core concept of lane detection is extracting the feature of lane from the image, state of art technology like deep learning, artificial intelligence has been proved having few improvement on the success of road lane detection if be applied directly. However, traditional algorithms including edge detection, region of interest definition and use the relation between continuous process by markov model , shown great improvement in computer vision.

The whole system can be split parts including into pre-processing, ROI (region of interest) detection and lane detection. Specifically, the pre-processing system first extracts the frame from the video captured by the camera. Then, it feeds these raw frames to the lane detection system. After pre-processing, colour transformation is performed. As the contrast between lane boundary and normal road plane is resemble, the boundary of the lane sign can be easily extracted from the image. For lane detection, most algorithms only consider gray level component.

Once the grayscale image is obtained, speed and accuracy of lane detection is improved by ROI

(Region of Interest) selection. This method will reduce redundant image data based on effective information. Therefore, selected ROI is used for feature extraction.

Feature extraction involves extraction of lane features such as color, texture, edge. Contrast between lane marking and road surface, constant width of lane marking, gradients at the marking are considered as the important features for lane detection. Lane detection step ties together the feature extraction and lane tracking stage. With the lane detection module, robust estimation of actual lane position is performed.

3.1 Typical Workflow

A typical lane line feature extraction process is as follows:

1. Convert original image to grayscale.
2. Darkened the grayscale image (this help in reducing contrast from discolored regions of road)
3. Convert original image to HLS color space.
4. Isolate yellow from HLS to get yellow mask. (for yellow lane markings)
5. Isolate white from HLS to get white mask. (for white lane markings)
6. Bit-wise OR yellow and white masks to get common mask.
7. Bit-wise AND mask with darkened image.
8. Apply slight Gaussian Blur.
9. Apply canny Edge Detector (adjust the thresholds—trial and error) to get edges.
10. Define Region of Interest. This helps in weeding out unwanted edges detected by canny edge detector.
11. Retrieve Hough lines.
12. Consolidate and extrapolate the Hough lines and draw them on original image.

4 Main Challenges

The challenge appears in the whole process of lane line extraction.

4.1 Road surface and lane marking

The lane mark has various types, including solid lines, dash lines and circular reflectors, physical barriers. On roads with poor maintenance conditions, we may even encounter roads without lane mark. Such situation particularly tests the algorithm's ability to extract lanes.

Moreover, the colour or the sunlight conditions could leads to a road surface with degraded appearance. Additionally, changing weather conditions, varying illumination make the problem more complex.

Figure 5. Road with poor maintenance conditions.

4.2 Shadow and Illumination Variation

When road contains both shadowed and non-shadowed areas, it may leads to the mislead of the boundary detection filter, which could result in wrong lane direction.

Figure 6. Road contains both shadowed and non-shadowed areas

4.3 Night Scenarios

At night time, the lane visibility is reduced due to which lane detection becomes difficult task. Because of the lack of sunlight, driver uses headlight and street lights to light up the scene in front of the vehicle and uses taillights to signal drivers behind them. Therefore, the filter may face difficulties while lane mark extraction due to noise edges caused by those lights. Headlights may cause different part of the image to have different levels of contrast for lane marks.

Figure 7. Road in night scenarios.

4.4 Rain and Fog

In rainy scenarios, as the surface of the road was covered with raindrops, the contrast level of image may be decreased, the intensity of noise will also be more serious.

In the presence of fog, contrast between lane marking and road surface will also reduces.

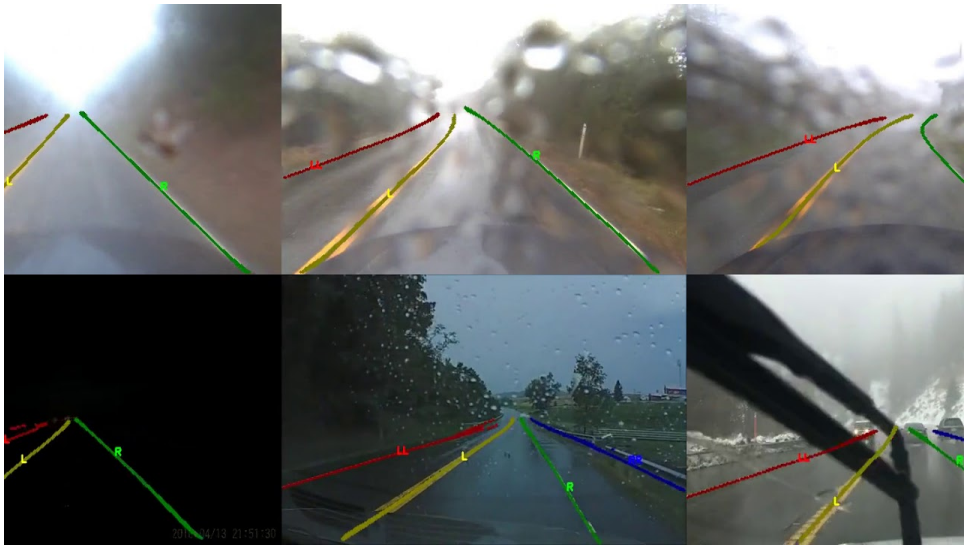


Figure 8. Road under rain and fog.

4.5 Challenge We Focus

In China, we also have many complex road situations including:

1. Unmarked road
2. Curved road
3. Complex lane sign
4. Some other disturb like speed bump

Our improvement will mainly focus on two points, the precising of extraction and the recognition of complex situation.

Firstly, the road lane is not always clear, in real situation, our detection system may be disturbed by series of bad environment like dirty road lane, extremely high sun light, road lane that is broken and lines in the night.

Secondly, at the same time when we extract the road lane, some other features on the road including speed notation, direction notation will also be extracted because they have same color like road lanes, we need to distinguish them from road lane.

And thirdly we will also try to analysis the road with complex structures, like diversion island, roundabouts, crossover, and some crossed road lines. These all signs will significantly increase the difficulty of road lane diction.

To solve these problems, we will try to find the relationship of the image in time domain and recognise the different road signs by basic image match technology. Also a series of basic image enhancement technology will be applied in extreme environment to improve the quality of image before we analysis the image.

5 Distribution of Tasks

5.1 Qingyuan Fan

Write the filter with conventional methods, pre-precessing the image

5.2 Tong Yuan

Profiling and improve the filter by using techniques like markov model on adjacent frame, extract the road lane from image.

Supplementary Material

The source code of this lab can be retrieved from
https://github.com/sparkcyf/SUSTech-EE326-Digital-Image-Processing-Project or
https://mirrors.sustech.edu.cn/git/fanqy2018/SUSTech-EE326-Digital-image-Processing-Project

References

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[2] Achmadnoer Sukma Wicaksana and Cynthia CS Liem. “Human-explainable features for job candidate screening prediction”. In: *2017 IEEE Conference on Computer Vision and Pattern Recognition Workshops (CVPRW)*. IEEE. 2017, pp. 1664–1669.